Claims

Semiconductor Structure with Active Zones

1. A semiconductor structure with active zones, such as a light-emitting diode or photodiode (10, 16, 24, 26, 36, 46, 54, 68, 74, 80), comprising a substrate (SUB) with at least two active zones (AZ1 - AZn), each of which emits or absorbs radiation of a different wavelength, a first (lower) active zone (AZ1) being grown on a surface of the substrate (SUB), at least one additional (upper) active zone (AZ1 - AZn) being epitaxially grown, and the active zones (AZ1 - AZn) being serially connected from the lower active zone (AZ1) to the upper active zone (AZn) via at least one dividing layer (TD1 - TDn) that serves as a low-impedance resistor, the dividing layer (TD1 - TDn) being designed as a reciprocally polar np- or pn-junction in the form of an isolation diode or tunnel diode, characterized in

that the semiconductor structure (10, 16, 24, 26, 36, 46, 54, 68, 74, 80) is designed as a multi-wavelength diode that emits or absorbs a defined number of light wavelengths, in that between the lower active zone (AZ1) and the upper active zone (AZn) one or more additional active zones (AZn) are epitaxially grown, in that the lowest active zone (AZ1) has a low energetic band gap, each of the subsequent active zones (AZ2 - AZn) having a higher energetic band gap than a previous active zone, and in that the semiconductor materials used for growing or epitaxing the isolation diodes or tunnel diodes (TD) either have an indirect band junction or an energetic band gap, which in each case is somewhat higher than the semiconductor materials that are used beneath it.

2. A semiconductor structure with active zones, such as a light-emitting diode or photodiode (10, 16, 24, 26, 36, 46, 54, 68, 74, 80), comprising a substrate (SUB) with at least two active zones (AZ1 - AZn), each of which emits or absorbs radiation of a different wavelength, a first (lower) active zone AZ1 being grown on a surface of the substrate (SUB), at least one additional (upper) active zone (AZ1 - AZn) being epitaxially grown, and the active zones (AZ1 - AZn) being serially connected from the lower active zone (AZ1) to the upper active zone (AZn) via at least one dividing layer (TD1 - TDn) that serves as a low-impedance resistor,
characterized in
that the semiconductor structure (10, 16, 24, 26, 36, 46, 54, 68, 74, 80) is designed as a multi-wavelength diode that emits or absorbs a defined number of light wavelengths, in that between the lower active zone (AZ1) and the upper active zone (AZn) one or more additional active zones (AZn) are epitaxially grown, in that the lowest active zone (AZ1) has a low energetic band gap, each of the subsequent active zones (AZ2 - AZn) having a higher energetic band gap than a previous active zone, and in that the dividing layer (TD1 - TDn) is designed as a metallic contact (K).

3. A semiconductor structure with active zones according to Claim 1 or 2,
characterized in
that the material of the substrate (SUB) is GaAs, Ge, InP, GaSb, GaP, InAs, Si, SiGe, SiC, SiGe : C, sapphire, or diamond.

4. A semiconductor structure with active zones according to at least one of the preceding claims,
characterized in

that the material of the active zones (AZ1 - AZn) is or contains one or more of the following materials: GaAs, GaInP (suitable compositions), AlGaAs (many suitable compositions), GaInAs (suitable compositions), AlInGaP (many suitable compositions), GaAsN, GaN, GaInN, InN, GaInAlN (suitable compositions), GaAlSb, GaInAlSb, CdTe, MgSe, MgS, 6HSiC, ZnTe, CgSe, GaAsSb, GaSb, InAsN, 4H-SiC, *a* - Sn, BN, BP, BAs, AlN, ZnO, ZnS, ZnSe, CdSe, CdTe, HgS, HgSe, PbS, PbSe, PbTe, HgTe, HgCdTe, CdS, ZnSe, InSb, AlP, AlAs, AlSb, InAs and/or AlSb.

5. A semiconductor structure with active zones according to at least one of the preceding claims,
characterized in
that a band emission diode (16) has the following structure:
   - a GaAs or Ge substrate (SUB)
   - a GaAs diode (AZ1) (lower diode) grown on the substrate,
   - on top of this, in alternating sequence, an isolation diode grown on the GaAs diode (AZ1), such as a GaInP isolation diode (TD) or an AlGaAs isolation diode (TD1 ... TDn), followed by a GaInP diode (AZ3) or AlGaAs diode (AZ3-AZn) grown on the isolation diode,

   the band emission range being defined in that the number of diodes (AZ1 - AZn) and the number and the width of the peaks define a coincident light emission range as it could not be achieved with a single peak, thus creating a resulting emission range.

6. A semiconductor structure with active zones according to at least one of the preceding claims,
characterized in
that on an active zone (AZn) an absorption layer (AbsS) containing the same material as the pn layer of the active zone (AZn) is grown.

7. A semiconductor structure with active zones according to at least one of the preceding claims,
characterized in
that each of the individual active zones (AZ1 - AZn) is equipped with its own metallic contact (K) for connection to a connecting lead.

8. A semiconductor structure with active zones according to at least one of the preceding claims,
characterized in
that a blended-color LED (26) (brown) has the following structure:
   - a GaA or Ge substrate (SUB),
   - a lower active zone (AZ1) made, for example, of GaInP (or AlGaInP), grown on the substrate,
   - a first isolation diode (TD1) made of GaInP or AlGaInP, grown on the lower active zone,
   - a center active zone (AZ2) made of AlInGaP, grown on the isolation diode,
   - a second isolation diode (TD2) and
   - an upper active zone (AZ3) made of AlInGaP, grown on the second isolation diode.

9. A semiconductor structure with active zones according to at least one of the preceding claims,
characterized in
that a blended-color LED (36) has the following structure:
- a GaAa or Ge substrate (SUB),
- a lower active zone (AZ1) grown on the substrate, followed by two additional active zones (AZ2 - AZn), between which a tunnel diode (TD1 - TDn) is arranged, and the upper active zone (AZn) having a metallic contact (K) for connection with an electrical terminal.

10. A semiconductor structure with active zones according to at least one of the preceding claims,
characterized in
that the metal contact (K, BK, LK) arranged between the active zones (AZ1 - AZn) is attached with adhesive, soldered, pressed, bonded or welded.

11. A semiconductor structure with active zones according to at least one of the preceding claims,
characterized in
that the lower active zone (AZ1) is made of an AlInGaP material having a wavelength of approximately 620 nm, in that the center active zone (AZ2) is made of an AlInGaP semiconductor material having a wavelength of approximately 550 nm, and in that the upper active zone (AZ3) is made of a GaInN semiconductor material having a wavelength ranging from approximately 400 to 450 nm.

12. A semiconductor structure with active zones according to at least one of the preceding claims,
characterized in
that one of the uppermost active zones (AZn) has a contact (BK) such as a bond contact.

13. A semiconductor structure with active zones according to at least one of the preceding claims,
characterized in
that the semiconductor structure (46) with the active zones (AZ1 - AZn, PD1 - PDn) is a blended-color sensor, the active zones (PD1 - PDn) being designed as photodiodes, and incident blended-color light being selectively absorbable in the associated active zones, from which a generated current can be selectively tapped.

14. A semiconductor structure with active zones according to at least one of the preceding claims,

characterized in

that the blended-color sensor (46) has the following structure:

- a GaAs or a Ge substrate (SUB), on the underside of which a metallic contact (K) is applied or grown, and on the upper surface of which a GaInP or AlInGaP photodiode (PD1) is applied or grown,
- on the photodiode an np isolation diode (TD1) made of an AlInGaP, AlGaAs, or GaInP material is applied,
- a second pn-junction made of an AlInGaP photodiode (PD2),
- an np isolation diode (TD2) and
- a third pn-junction is designed as the GaAlN or AlGaInN photodiode (PD3).

15. A semiconductor structure with active zones according to at least one of the preceding claims,

characterized in

that the first photodiode (PD1) lies within a wavelength of λ = 600 nm to 680 nm, in that the center photodiode (PD2) lies within a wavelength of λ = 550 nm, and in that the third photodiode (PD3) lies within a wavelength of λ = 400 nm to 450 nm.

16. A semiconductor structure with active zones according to at least one of the preceding claims,

characterized in

that each of the light-detecting photodiodes (PD1 - PDn) is equipped with a metallic contact (K) for connection to an electrical terminal.

17. A semiconductor structure with active zones according to at least one of the preceding claims,

characterized in

that the semiconductor structure with the active zones, such as a light-emitting diode or photodiode, forms a colored display (80).

18. A semiconductor structure with active zones according to at least one of the preceding claims,

characterized in

that the colored display (80) is formed from a plurality of light-emitting semiconductor devices (82) according to at least one of claims 1 through 17, one pixel (82) of the colored display (80) corresponding to a light-emitting semiconductor device, and each pixel (82) and the corresponding colors being selectively activated.